

Performance Work Statement

Contract Number: STREAMS 2

Task Number:

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Period of Performance: October 1, 2012 – October 1, 2013

Title: Storm Water LID BMP Model Validation Study

I. Background:

Combined Sewer Overflows (CSOs) account for the discharge of approximately 850 billion gallons of sewerage into waterways annually (US EPA, 2004). Sanitary Sewer Overflows (SSOs) occur from 25,000 - 75,000 times annually with sewerage discharges totaling from 3 to 10 billion gallons (US EPA 2004). CSOs and SSOs are episodic and correlated with wet weather inflows. Rivers, streams, and creeks most frequently receive CSO discharge containing contaminants including heavy metals, nutrients, pathogens, and biologically degradable compounds. These uncontrolled discharges have a significant impact on the environment and human health.

Low impact development BMP controls for stormwater management are gaining in popularity and making their way into standard practice. The idea behind LID BMPs is to increase the potential for infiltration of runoff; thereby, decreasing runoff volume and attenuating peak flows. Application of LID BMPs is a decentralized strategy requiring the placement of multiple BMP facilities within an urban drainage to achieve runoff control objectives. This presents a design challenge since there are numerous potential sites for BMP placement and several

different types of BMPs each with their own siting criteria. Modeling is an important aspect of decentralized facility design, as it can be used to evaluate the effectiveness of coordinated LID BMP placements prior to construction.

The US EPA has recently added LID modeling capabilities into version 5.0 of the Storm Water Management Model (SWMM5). New features and BMP unit models for SWMM5 have been planned and the model is currently under active development. The LID unit process modeling algorithms are based on work documented in the scientific literature. The LID models developed thus far include bio-retention cells, green roofs, porous pavement, infiltration trenches, and vegetated swales.

The next step in the model development process is to evaluate the accuracy with which these LID BMP models can predict runoff volume reduction and peak flow attenuation. When developing models a tradeoff exists between model complexity and accuracy. SWMM5 is frequently used for facility placement planning during the design phase of a project; therefore, the BMP models should be accurate without burdening the user with extensive data requirements or confuse them with unnecessary complexity. To strike the right balance and assure an appropriate level of accuracy, the objective of this task order is to benchmark the performance of SWMM's LID module.

II. Project Description:

The purpose of this task order is to perform a validation study on LID BMP models being actively developed by the US EPA for SWMM5. The primary outcome of this study will be a report documenting the fidelity with which the LID BMP models can simulate real world observations taken at existing LID stormwater control units. The BMP models will be modified and updated based on the results of the validation study. Thus, improved LID BMP models will be a secondary outcome of the study.

The target audience for this task is US EPA personnel developing SWMM5 and ultimately the model's users who will benefit from improved LID BMP models. This study supports programmatic research objectives related to the improvement of storm water LID BMP modeling capabilities.

III. Objective:

The overall objective of this task order is to test model performance of SWMM's LID module against LID data sets collected from various sources. The LID control models to be tested include:

1. Bio-Retention Cells

2. Green Roofs
3. Porous Pavement
4. Infiltration Trenches
5. Vegetated Swales

Task 1 is to develop a QAPP to insure the integrity and quality of the validation study. Task 2 is to identify and aggregate the LID performance data to be used in the validation study. Task 3 is the development and population of a database to organize the LID performance data and metadata describing the physical characteristics of the LID's themselves. Task 4 is the evaluation of LID model performance. And, Task 5 describes project wrap-up and the final report.

IV. Detailed Task Descriptions:

Each initial deliverable shall be provided to the TOCOR in draft form for review and comment. The contractor shall incorporate the TOCOR's review comments into revisions of the drafts. All drafts and final reports shall be approved by the TOCOR.

The contractor shall perform the following tasks, numbered 1 through 5.

Task 1: Develop QAPP

All work conducted under this Task Order shall be performed pursuant to an EPA-approved Quality Assurance Project Plan (QAPP) The QAPP shall outline the approach and measures the Contractor will implement to ensure a high standard of quality in secondary data, data analysis, and written deliverables. The work plan shall explain when the QAPP will be submitted based on the specific requirements of the TO. The Quality Assurance Project Plan is subject to review and approval by the TOCOR and the EPA QA Officer. Work on Tasks 1-5 cannot proceed until the contractor receives notification of the QAPP approval from the Task Order COR.

The contractor shall prepare a Category IV Quality Assurance Project Plan (QAPP) in accordance with applicable sections of "[EPA Requirements for Quality Assurance Project Plans for Modeling](#)." Task 2 of this task order involves the use of primary and/or secondary data. To assure the quality of the secondary data used under this task order, the QAPP must address the applicable requirements identified in "[NRMRL QAPP Requirements for Secondary Data Research Projects](#)." Task 3 involves the design and development of a database to organize the data. To assure the quality of the database designed under this task order, the QAPP must address the applicable requirements identified in "[NRMRL QAPP Requirements for Software Development Projects](#)." Task 4 involves the validation of Stormwater LID BMP models. To assure the quality of the validation study results generated under this task order, the QAPP

must address the applicable requirements identified in “[NRMRL QAPP Requirements for Research Model Development and Application Projects](#).”

Deliverable A: A draft QAPP submitted to the TOCOR for review. Due thirty (30) days maximum from award of contract.

Deliverable B: A revised QAPP addressing TOCOR’s and QA officer’s comments. Due one week after receiving comments from the TOCOR. Allow one week for comments and one week for approval.

Task 2: LID Performance Data

Data is a critical element of a model validation study. The purpose of Task 2 is to identify a collection of hydrologic performance data sets (from both EPA and non-EPA funded projects) for each of the aforementioned LID controls that are available for testing. Accomplishment of this task also requires the organization of the data for entry into a database that will facilitate their testing with SWMM 5.

Secondary LID BMP performance data will be identified and collected for the BMP model validation study. The data shall be vetted to insure that it meets the data requirements established for the model validation study in the QAPP. The following data sources will be considered:

1. Peer Reviewed Scientific and Engineering Literature
2. Scholarly Theses and Dissertations
3. Published EPA Reports
4. Data from Unpublished EPA Field Studies (supplied by TOCOR)
5. BMP Performance Databases

A minimum of three validation data sets will be identified for each of the five LID BMPs being validated as part of the study. The TOCOR reserves the final authority to select and approve which of the data sets identified will be included in the validation study.

The contractor shall prepare an annotated bibliography documenting the sources of secondary data selected for the validation study. The annotation will contain a summary of the metadata associated with each data set including: LID BMP Type, physical characteristics of the BMP, antecedent conditions, number of events in which data were collected, the types of data collected, and frequency of data collection, the number of data points collected, the original purpose for which the data was collected, the quality of the data, availability of the data.

Deliverable A: Draft annotated bibliography describing the source and metadata associated with each data set identified and selected as part of the validation study. Due five (5) weeks after approval of QAPP.

Deliverable B: Final annotated bibliography describing the source and metadata associated with each data set selected and approved by TOCOR. Due eight (8) weeks after approval of QAPP.

Task 3: Database Development

Database tables and queries shall be designed and the data identified in Task 2 shall be entered into said database. The design of the database and data queries shall be reviewed and approved by the TOCOR. Any modifications to the database design will be incorporated prior to entry of the secondary data.

Subtask 3.1 Database Design

Database tables, relationships between tables, and queries shall be designed to logically organize and facilitate the retrieval of the secondary data for the individual LID BMP models being validated. The database shall also contain the metadata describing the physical characteristics of the LID BMP configuration from which the data was collected. The metadata shall be of sufficient detail to construct model representations of the BMP configurations in Task 4. Database queries and reports should be designed to facilitate model development in Task 4.

The database design documentation shall include a description of the fields present in each table and a diagram showing the relationships between tables. The report will also describe the queries used to retrieve the data. Lastly, the report will provide example use cases illustrating how the database should be accessed and used.

Deliverable A: Draft documentation describing the database and query design. Due three (3) weeks after QAPP approval.

Deliverable B: Revised documentation describing the database and query design addressing TOCOR's comments. Due five (5) weeks after QAPP approval. Allow one week for TOCOR's comments.

Subtask 3.2: Populate Database

The validation data identified in Task 2 shall be entered into the database. Further, QA/QC checks shall be performed to insure the quality of the secondary data resident in the database.

Deliverable: The database populated with secondary LID BMP performance data. Due eight (8) weeks after QAPP approval.

Task 4: Model Development and Evaluation

The purpose of this task is to develop SWMM5 models representing the LID configuration for each of the data sets identified. Once developed the models will be run and compared against the data sets identified in Task 2.

Subtask 4.1: Model Development

Models representing the LID configurations used in the datasets identified in Task 2 shall be developed in SWMM5. Data describing the physical configuration of each LID has been collected, organized, and entered into the database designed in Task 3. This data will be formatted into SWMM 5 input files to facilitate validation testing. The resulting LID BMP models will be used in subsequent Tasks.

Deliverable: SWMM 5 input files for each LID configuration corresponding to the data sets identified in Task 2. Due thirteen (13) weeks after QAPP approval.

Subtask 4.2: Model Performance Evaluation

A model performance evaluation will be conducted to identify systemic model errors or other deficiencies in the ability of SWMM5 to reasonably match observed LID performance. Anomalous model performance results will be documented and discussed in the project report.

The model performance evaluation report shall contain tables, figures, charts, and prose that clearly describe the model performance for each LID type and each dataset.

Deliverable: Draft report evaluating model performance results. Due fifteen (15) weeks after QAPP approval.

Task 5: Project Wrap-up and Final Report

A final report describing the work done under this project shall be prepared. The report shall be professionally written and word processed. The report should fully document the work performed by the contractor for Tasks 1-5 of this Task Order.

The project Final Report shall contain the following sections:

1. Workplan
2. QAPP

3. Annotated Bibliography of Data Sources
 - a. Bio-Retention Cell Data
 - b. Green Roof Data
 - c. Porous Pavement Data
 - d. Infiltration Trench Data
 - e. Vegetated Swale Data
4. Database Documentation
5. Model Performance Evaluation
 - a. Bio-Retention Cell Performance
 - b. Green Roof Performance
 - c. Porous Pavement Performance
 - d. Infiltration Trench Performance
 - e. Vegetated Swale Performance
6. Appendix
 - a. SWMM 5 Input Files

Deliverable A: A draft Final Report submitted to the TOCOR for review. Due seventeen (17) weeks after QAPP approval.

Deliverable B: A revised Final Report addressing TOCOR's comments. Due nineteen (19) weeks after QAPP approval. Allow one week for TOCOR's comments.

VII. Schedule and Deliverables:

The period of performance for this task order is anticipated to be eight (8) months. Please refer to previous section for deliverables and due dates.